MONTHLY NOTICES

OF THE

ROYAL ASTRONOMICAL SOCIETY.

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WILLIAM HUGGINS, ESQ., F.R.S., President, in the Chair.

William James Allsup, Esq., 5, Eastcombe Villas, Blackheath; John William Durrad, Esq., 12, Lincoln Street, Leicester; and The Rev. Joseph Ferguson, 108, Lupin Street, Birmingham;

were balloted for and duly elected Fellows of the Society.

Mr. Carrington's Sun-Spot MSS.

Lord Lindsay has recently presented to the Society the drawings of Solar Spots, and manuscript books of observations and reductions of observations, which were made by the late Mr. Carrington, between the years 1853 and 1871. The results derived from a great portion of these observations have already been published in Mr. Carrington's book on Sun-Spots; but the interest attaching to the collection is still great, as it contains the original data from which the most accurate determination of the position of the Sun's axis and the drift of the photosphere in the various heliocentric latitudes have been determined.

These manuscripts were recently sold by public auction, and were bid for on the part of the Society; but they were purchased by a bookseller, from whom Lord Lindsay has since bought them, for the purpose of depositing them in our library, which is already comparatively rich in Sun-Spot manuscripts, as will be seen from the following list:

1 vol. of Drawings, by Charles B. Adams. Aug. 1819—March 1822.
3 vols. of Drawings, by J. W. Pastorff. 1819–1833.
2 vols. of Drawings, by the Rev. T. J. Hussey. 1826–1837.
1 vol. of Drawings, by Mr. Lawson. 1831–1832.
1 vol. of Drawings, by Capt. C. Shea. 1847–1866.
2 vols. of Drawings, by the Rev. T. Chevallier. 1847–1849.
Detached Drawings of the Sun, by Sir J. Herschel. 1846.

Mr. Carrington's collection consists of—

Three folio volumes drawings of Sun-Spots, made on a scale of 12 inches to the Sun's diameter. In all cases the whole of the Sun's disk has been drawn, and the positions of the north point and the Sun's axis have been marked upon the page with great care. The places of the spots and the general outline of the groups and penumbræ were, it is believed, laid down by means of an enlarged image of the Sun, which was thrown upon the drawing paper; and the details were afterwards roughly sketched in without any pretension to great accuracy.

Three large quarto volumes of observations of the Positions of Spots. These observations were made by observing the intervals of time between the transits of the spots and the transits of the preceding and following limbs of the Sun across wires in a fixed telescope.

Seven large quarto volumes, containing the reductions of the above observations.

And a folio volume, filled with drawings of groups of Spots as seen upon successive days, placed one below the other on the page, so as to show at a glance the history of the group, and its drift in heliocentric latitude and longitude. A. C. R.

Note on a Starlit Transit Eyepiece.

By Dr. Royston-Pigott, M.A., F.R.S., &c.

In review of the recent weather, so hostile to nice observations, it is with some diffidence that I venture to draw the attention of the Society to the little contrivance which I have named the *Starlit Transit Eyepiece*, as its name implies, self-illuminating.

It essentially consists of transparent lines drawn on a film of silver of a fine blue tint, deposited by Martin's process on a disk of glass. This film admits the view of a star, which can be seen passing across the field and flashing brightly at the instant of transit across the vertical parallel transparent lines. The breadth of the lines can be regulated so that more or less of the spurious disk of a star can be shown in transit. For a 60-inch Transit—the size of the instrument I employ—the lines are ruled $\frac{1}{20}$th of an inch apart, which gives 11·4 seconds of time for the transit of an equatoreal star; spaces of $\frac{1}{20{\cdot}1}$ give 12 seconds.

The lines can be ruled with great exactitude within a 10,000th of an inch: 1,000th of an inch corresponds nearly to a quarter of a second, and 10,000th to the fortieth part of a second. In the centre, below the film, is an indicator, visible by star-light, showing the central line; and the film is removed at the sides so as to show the approach of the star to the transparent lines,

three, five, or seven in number, according to the requirements of the observer.

The films also can be deposited of any degree of opacity, according to the power of the instrument, and can be renewed at a small cost, and be readjusted by proper screws with great readiness to a distant meridian mark.

The diffraction effects peculiar to a cylindrical thread are considerably modified by a bright line formed by plane surfaces. The spider line usually employed is nearly cylindrical, and when illuminated by reflection a cylindrical image only is formed, which does not extend over the whole breadth of the line; whilst an unillumined portion, invisible to the eye, obscures part of the star disk after apparent transit.* An interesting appearance is seen when a good-sized star is put out of focus, so as to show a clearly defined enlarged disk.

As the disk transits over the transparent lines a brilliant line starts into view: at first a very short line, gradually and rapidly lengthening, and again shortening to its point of disappearance.

Applied to my 8-foot Equatoreal with $5\frac{1}{4}$-inch aperture the effect was beautiful, and produced a strong illusion of the bright line or star being stationary and the transparent bars moving. The inconvenience of artificial illumination with this instrument renders a starlit transit particularly desirable.

The silver film appears to answer very much better than any other film I have hitherto tried; for several attempts have been made with various varnishes and ruled lines; but these varnishes are apt to coalesce, and any variation in thickness and quality destroys uniformity of effect.

In solar transits, provided the brilliance of the solar disk has been sufficiently subdued, whether by Barlow's silvered lenses, polarisation, or neutral glasses, or still better by Mr. Christie's solar eyepiece, the flashing of the edge of the solar limb, as it successively passes across the transparent lines, is a phenomenon worthy perhaps of attention; but whether for solar observations this transparent method is in any degree as trustworthy as opaque line† observations is a point on which I can at present offer no opinion.

Messrs. Horne & Thornthwaite, I wish to add, have beautifully carried out the design of the writer, and have placed at the disposal of the Greenwich, Oxford, and Cambridge Observatories, and of those of Lord Lindsay and Dr. Huggins, five of these instruments.

Hartley Court, Reading,
March 6, 1876.

* The behaviour of minute reflecting threads (especially of spun glass) under the microscope gives some pretty illustrations of cylindrical images, such as those here alluded to.

† These lines may perhaps be successfully photographed for Solar Transits.

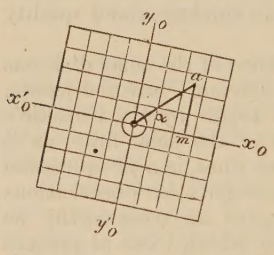
The Stereo-micrometer.

By Professor Chas. V. Zenger.

The stereo-micrometer is a binocular apparatus, to be fitted to any kind of astronomical refracting or reflecting telescope, and is used for measuring at once small angles in the field of view, as, for instance: The position-angles of solar protuberances; of solar spots; of close double stars; of difficult comes; of the satellites of *Jupiter*, *Saturn*, and *Uranus*; finally, of the spectral lines in solar and stellar spectra.

It is also intended, if used with a day eyepiece, to give the position of any terrestrial object, by placing the telescope at two different points, a and b, of a stand-line, measuring thus the coordinates x and y of the same point in two positions, and therefore its parallax, or the distance z by the horizontal parallax, to be deduced from the measurements made on the micrometer, viz., the differences of x and y.

It is constructed on the stereoscopical principle, and consists of two draw tubes exactly similar, with homofocal lenses, both mounted parallel to the axis of the telescope, with an arrangement for different distances of eyes. Looking through the double eyepieces, one being placed before the image of the star in the focus of the telescope, the other having been placed before an ocular micrometer divided in $\frac{1}{10}$ mm or $\frac{1}{20}$ mm, forming a grate of small squares on one side of a thin plate of mica; the image of the micrometer is thus projected on the images of the stars in the telescope, the fifth or inside line ($x_o\ x_o'$) of it being set parallel to the diurnal motion; it is easily to be conceived that if a be a comes of a planet or star placed with its centre at o, $am=y$, $om=x$ will be respectively the differences of declination and right ascension of both, and $\tan \alpha = \frac{y}{x}$ will measure the angle between the centre of the star and its comes, taking the direction of the diurnal motion as zero.



The diameter of the planet, the distance of the satellite, the angle of position, or the differences in Declination and R.A. may may be thus observed at a single glance, marking only the number of the small square where the satellite (a) will be seen, and its position in it.

In my Busch Refractor, 4″ aperture and $1^m{\cdot}5$ focal distance, the image of the Sun holds nearly 15^{mm} in diameter: 15^{mm} therefore being equivalent to 300 divisions of the micrometer divided in $\frac{1}{20}$ mm, and magnified 25 times by a Ramsden eyepiece, one division being $\frac{1920''}{300} = 6''{\cdot}4$, it is easy to discern by the eye $\frac{1}{10}$ to $\frac{1}{20}$ of a division in both directions, or nearly $0''{\cdot}6$ to $0''{\cdot}3$. There

could easily be placed in the micrometric eyepiece a pair of movable wires to measure accurately in both directions the position of a in the small square.

The fifth and tenth squares are marked red and blue to read easily the number of the little squares, where a is visible, and on the back side of the mica-plate there is a rough numbered division for the same purpose, sufficiently visible, because the mica is very thin.

The eye, when first looking through the double eyepiece, cannot discern whether the micrometer be placed before the right or the left eye, at least if there is not too large a difference of focus between both eyes.

The greatest usefulness will be for measurements of faint celestial objects suffering from illumination of the wires in the field; for it is a physiological fact that the left eye, for instance, may look on the sharply illuminated micrometer without affecting the perfect visibility by the right one of faint comes or satellites, as those of *Saturn* for instance, allowing thus of less aperture for such difficult work, and finishing measurement in a moment, with a single glance at the object. Finally, we can by means of it measure the position of protuberances relative to the solar equator, their height and diameters; also, by simply fixing the number of squares where they are visible and the amount, the smallest displacement of spectral lines will be likewise measurable by it.

Its use is universal for every kind of astronomical and spectroscopical work; but it also could be used for geodetical surveys, giving three coordinates, viz., x, y, and by their differences the parallax of every point taken from a stand-line (a b) of known length, from which parallax may be deduced the horizontal parallax, and therefore the distance, or the third coordinate z, for every point measured with the stereo-micrometer.

I made also use of photography for the same purpose, taking with an orthoscopic lens two views on both ends of the stand-line, and using plates, on which were formerly made photographs of a similar square micrometer from a drawing on paper or cardboard. These photographs, well dried, were covered again with a sensitive film of collodion, and oriented exactly on the same point of the landscape for every image taken. Both projections of the landscape gave x, y and x', y' for both ends (a and b) of the stand-line, and their differences the parallax of every point (or z), and the distance of the point from the optical centre of the orthoscopic lens.

The shrinkage of the collodion film, at least on albumenised plates, will have scarcely a perceptible influence on the exactness of measurement, inasmuch as it will be nearly uniform for both films, the first bearing the image of the micrometer and the second film with the photograph of the landscape being superposed on the former. It is essential to use always the same collodion, of the same thickness, and sensitised in the same bath.

Prague, 1876, *January*.

Comparison of Recent and Former Observations of B.A.C. 793, and Remarks on the alleged Variability of its Proper Motion. By Edwin Dunkin, Esq.

The few stars which are known to have an irregular proper motion have given to this subject a peculiar interest, especially since the disturbing causes in the cases of *Sirius* and *Procyon* have been discovered. When, therefore, a suspected variability in the proper motion of so small a star as B.A.C. 793 was pointed out by Professor Smyth (*Monthly Notices*, vol. xxxv. pp. 356–61), it appeared to me interesting to inquire whether any evidence could be deduced from other sources for or against this apparent irregularity of proper motion. Professor Argelander had previously, in volume vii. of the *Bonn Observations*, discussed the proper motion of this star in a most exhaustive manner, in common with 249 others, without detecting any variability calling for especial notice. But the tables given by Professor Smyth, formed from observ tions extending over thirty years, at the Edinburgh Observatory, exhibited such a decided and gradual change in the proper motion since 1837, both in R.A. and N.P.D., that it was thought worth while to examine the few Greenwich observations of the star to ascertain whether they gave any tendency towards a confirmation of Professor Smyth's numbers. Unfortunately, this star was not observed at Greenwich after 1858, and it was subsequently to that date that the start in the Edinburgh proper motion in N.P.D. began. The materials were therefore not very good for the comparison. But by dividing the observation-groups into intervals—much too short, however, to expect even moderate accuracy—it was shown that there was some general resemblance in the resulting Edinburgh and Greenwich values for proper motion in R.A.; but in the absence of later observations, it was impossible to pronounce, from this imperfect comparison, any decided opinion on the reality of the irregular changes in the amount of the proper motion given in Professor Smyth's paper.

The materials in hand have been, however, much increased by a series of observations since made at the Royal Observatory, and, through the kind permission of the Astronomer Royal, I have been enabled to avail myself of the results of this series, consisting of ten observations of B.A.C. 793 in both elements, and seven of a small preceding neighbouring star, Weisse's Bessel, (1) II. 453, which had also been previously observed four times between 1858 and 1863, evidently by mistake for the larger star. The comparison of the places of these two stars has given a valuable and independent result for the proper motion of B.A.C. 793. I have also officially received a paper sent by Mr. Stone to the Society—inserted in the present number of the *Monthly Notices*—in which he states that in 1837 the star B.A.C. 793 was observed at the Cape Observatory fourteen times in

right ascension, and that the Cape mean observed right ascension for that year differs as much as $0^s.315$ from that determined by the Edinburgh observations, a quantity sufficient, if the Cape right ascension were substituted for that of Edinburgh, to cause most of the apparent variability to disappear. It may be remarked, however, that the Greenwich observed mean right ascension determined from one observation in 1837, and four in 1838, reduced to 1837, January 1, is nearly the mean of the Edinburgh and Cape results.

It is not necessary at present to enter into more detail than what is required to determine the resulting proper motion from a comparison of the separate means of the observations of Lalande, Piazzi, Greenwich (1837–38), Greenwich (1845–46), and Greenwich (1852–58), with the ten observations made at the Royal Observatory in the latter end of 1875 and the beginning of 1876, the mean R.A. and N.P.D. being reduced to 1876, January 1. All the Greenwich observations having been corrected for the elapsed part of the proper motion depending on the fraction of the year, the different values for proper motion in Table III. refer in each case to a time half-way between the two epochs.

In Tables I. and II. the reduced mean R.A. and N.P.D. of the star at the epoch of each catalogue are given, and also for 1876, January 1, formed by applying to the former the geometrical precessions for the mean year multiplied by the number of years between each epoch and 1876. The R.A. and N.P.D. from Lalande and Piazzi's Catalogues are the corrected places used by Argelander in volume vii. of the *Bonn Observations*.

R.A. Table I.

Catalogue.	Mean Epoch of Obs.	Mean Epoch of Cat.	No. of Obs.	Mean R.A. at Epoch of Cat. h m s	Geometrical Precession. s	Mean R.A. 1876, Jan. 1. h m s
Lalande	1794·0	1800	1	2 25 7·010	3·1577	2 29 7·000
Piazzi	1800·9	1800	7	2 25 7·900	3·1577	2 29 7·890
Greenwich	1837·0	1837	5	2 27 9·017	3·1595	2 29 12·238
Greenwich	1855·0	1855	29	2 28 8·066	3·1605	2 29 14·437
Greenwich	1876·0	1876	10	2 29 16·920	...	2 29 16·920

N.P.D. Table II.

Catalogue.	Mean Epoch of Obs.	Mean Epoch of Cat.	No. of Obs.	Mean N.P.D. at Epoch of Cat. ° ′ ″	Geometrical Precession. ″	Mean N.P.D. 1876, Jan. 1. ° ′ ″
Lalande	1794·0	1800	1	84 4 44·45	16·059	83 44 23·97
Piazzi	1800·9	1800	7	84 4 31·95	16·059	83 44 11·47
Greenwich	1845·0	1845	5	83 51 23·12	15·995	83 43 7·28
Greenwich	1855·0	1855	31	83 48 28·89	15·978	83 42 53·35
Greenwich	1876·0	1876	10	83 42 21·31	...	83 42 21·31

The annual proper motions deduced from the preceding tables are as under :

Table III.

Catalogues.	Mean Year for Proper Motion.	Proper Motion in R.A. s	Proper Motion in N.P.D. "
Lalande and Greenwich (1876)	1835·0	+0·1210	−1·496
Piazzi ,,	1838·0	+0·1202	−1·466
Greenwich (1837) ,,	1856·5	+0·1201	...
Greenwich (1845) ,,	1860·5	...	−1·483
Greenwich (1855) ,,	1865·5	+0·1182	−1·526

The star W.B. II. 453 having been observed several times between 1858 and 1863, the values of its proper motion have been approximately determined from a comparison of these with the recent observations to be $-0^{s}\cdot001$ in R.A. and $-0''\cdot09$ in N.P.D. In comparing the relative positions of this star and B.A.C. 793 at the two epochs these proper motions have been applied to the places of W.B. II. 453 for the interval between the years 1855 and 1876. The following are the observed differences between the mean R.A. and N.P.D. of the two stars :

		Diff. of R.A. s	Diff. of N.P.D. "
B.A.C. 793 − W.B. II. 453	1855 Jan. 1	+37·281	−13·28
,, ,,	1876 ,,	+39·777	−44·76
Excess of B.A.C. 793 in 21 years		+ 2·496	−31·48

From the direct comparison, therefore, of the observed places of these two stars we obtain the following independent values of the proper motion of B.A.C. 793, in both elements, which are probably not far from the true ones:

	Proper Motion in R.A. s	Proper Motion in N.P.D. "
1855, Jan. 1, to 1876, Jan. 1	+0·1189	−1·499

These values are almost identical with those for the corresponding group in Table III.

Without entering into further detail, I think that the evidence given above is sufficient to warrant the conclusion that the proper motion of B.A.C. 793 has not really changed during the present century. The wonder is that the results for the different groups agree so well, considering that Lalande's place depends only on one observation in each element, and the com-

paratively inferior instruments with which both Lalande's and Piazzi's observations were made. The proper motion in R.A. certainly shows a gradual diminution in the value from group to group, but by a quantity so minute that it probably owes its origin more to accident than to any other cause. If there had been any real changes similar to those indicated by the Edinburgh observations, they must have appeared in the resulting Greenwich values, which the excellent series of observations lately made at the Royal Observatory has enabled me to determine.

Kenwyn, Kidbrooke Park Road, Blackheath,
1876, *March* 7.

On a Supposed Variability of the Proper Motion of B.A.C. 793. By E. J. Stone, Esq., F.R.S., Her Majesty's Astronomer, Cape of Good Hope.

In the *Monthly Notices* for May 1875 there appeared an interesting paper by Professor C. Piazzi Smyth, in which an attempt is made to prove that the proper motions of the star B.A.C. 793 have varied sensibly since 1837. On reading the paper, I was much struck with the fact that the whole argument in favour of the variability of the proper motion turns upon the extreme accuracy of the Edinburgh observations made in 1837. I find that the star B.A.C. 793 was observed at the Cape no less than fourteen times in Right Ascension in the year 1837. Unfortunately, it was not also observed in North Polar Distance.

If we assume the proper motion in Right Ascension to be $0^s{\cdot}120$, then we have:

1837 Jan. 1 R.A. of B.A.C. 793 = $2^h\ 27^m\ 9^s{\cdot}155$.

The number of observations upon which this result depends is 14, and the fraction of the year for which proper motion has been applied is 0·89.

It will be seen that the Right Ascension deduced from the Cape observations differs considerably from the result of the three Edinburgh observations.

If we bring up the Right Ascension deduced from the Cape observations with the proper motion $+0^s{\cdot}120$, the following table will exhibit the excess of the computed results over the observed result given in Professor Smyth's paper :—

	Excess of Computed R.A. s	No. of Obs.
1851	−0·07	5
1852	−0·06	4
1855	−0·00	5
1858	+0·01	6
1861	+0·05	2
1862	+0·06	3
1863	+0·03	3
1865	+0·01	3
1866	+0·02	1
1867	+0·03	3

The evidence in favour of the supposed variability of the proper motion in Right Ascension appears to me but very slight indeed.

1876, *Jan.* 20.

On the Proper Motions of the Two Components of the Binary System α Centauri.

By E. J. Stone, Esq., F.R.S., Her Majesty's Astronomer, Cape of Good Hope.

In the formation of the Cape General Catalogue of Stars for 1860, I adopted $-0^{s}\cdot470$ and $-0''\cdot83$ for the *common* proper motions of the stars α_1 and α_2 *Centauri* in R.A. and N.P.D. respectively. In the Melbourne General Catalogue of Stars for 1870, the adopted *common* proper motions are $-0^{s}\cdot480$ and $-0''\cdot49$. Attention has been called to the discrepancy between these adopted values, particularly in N.P.D., in *Nature* of 1874, November 4. The writer appears to consider the Melbourne value the more correct, and that the Cape value depends upon Lacaille's declination. The point here raised is of some importance. I have, therefore, collected together the data available to me, and discussed them in the present paper.

The following observations will be made use of:—

α Centauri.

(1st magnitude).

	Epoch.	R.A. h	m	s	No. of Obs.	N.P.D. °	′	″	No. of Obs.
1	1750	14	22	49·9		149	47	8	
2	1825	14	27	(46·77)		150	6	19·1	171
3	1830 F	14	28	7·47	11	150	7	32·68	8
4	1830 J	14	28	7·98	21	150	7	35·40	13
5	1833	14	28	19·74	27	150	8	20·9	20
6	1840	14	28	47·45	189	150	10	7·10	47
7	1860	14	30	7·23	2	150	15	19·55	160
8	1870	14	30	47·07	20	150	17	53·93	20
9	1871					150	18	9·72	32
10	1872					150	18	24·64	3
11	1875	14	31	7·07	4				

α Centauri.

(2·3 magnitude.)

	Epoch.	R.A. h	m	s	No. of Obs.	N.P.D. °	′	″	No. of Obs.
1	1750	14	22	48·2		149	47	24	
2	1825	14	27	(45·04)		150	6	37·4	44
3	1830 F								
4	1830 J	14	28	6·44	7	150	7	51·8	7
5	1833	14	28	18·22	26	150	8	35·5	17
6	1840	14	28	46·09	180	150	10	20·78	33
7	1860	14	30	7·06	3	150	15	18·68	3
8	1870	14	30	47·50	10	150	17	43·69	13
9	1871					150	18	0·11	29
10	1872					150	18	15·38	3
11	1875	14	31	7·70	4				

The observations in the first group are Lacaille's; the second contains Brisbane's Observations; the fourth, Johnson's St. Helena Observations. The observations in the eighth group are taken from the Melbourne Catalogue; the other observations are all Cape Observations. I have no confidence in Brisbane's Right Ascensions, and I have not used them in the present enquiry. Taylor's Catalogue is not available: the observations extend over many years, and the mean year of observation is not given in the Catalogue.

There are two ways in which these observations may be discussed with reference to the proper motions of the stars. If the stars are so far apart from each other that their common gravitation does not affect, by quantities yet observationally sensible, the proper motions existing at any epoch, there is no legitimate ground for an *à priori* assumption of any proper motion common to the stars. The proper motions of each star must be determined in the usual way, and applied to the reductions of the place of the star from one epoch to another. If on the other hand, we assume that the stars are so near to each other that the effects of their common gravitation are observationally sensible, we have no right to expect that the proper motions determined in the usual way for each star will be constant. The only legitimate assumption is, that the proper motion of their common centre of gravity may, from our experience in the case of other stars, be sensibly constant. I will discuss the observations on both assumptions.

The proper motions of the two stars in R.A. and N.P.D. will be represented by x_1, y_1, x_2, y_2. The true Right Ascensions and North Polar Distances for 1870 will be assumed to be:

h	m	s	°	′	″
14	30	$47^s{\cdot}07 + a_1$,	150	17	$53''{\cdot}93 + d_1$
14	30	$47^s{\cdot}50 + a_2$,	150	17	$43''{\cdot}69 + d_2$.

On account of the existence of systematic errors, some limit must be fixed to the weight which can be assigned to a group of observations. I have fixed upon 36 as the extreme weight. Up to that limit I roughly weight the residuals in proportion to the number of observations in each group. The following are the equations of condition for each star:—

1st Magnitude Star.

Group.		R.A. s	$\sqrt{\omega}$	C.−O. s
1	$a_1 - 120\ x_1 =$	57·69	1	+2·48
3	$a_1 - 40\ x_1 =$	20·47	5	−0·30
4	$a_1 - 40\ x_1 =$	19·96	4	+0·21
5	$a_1 - 37\ x_1 =$	18·81	5	−0·14
6	$a_1 - 30\ x_1 =$	15·17	6	0·00
7	$a_1 - 10\ x_1 =$	5·17	1	0·00
8	$a_1 - 0\ x_1 =$	0·00	5	+0·17
11	$a_1 + 5\ x_1 =$	−2·53	2	+0·20

$$133\ a_1 - 3755\ x_1 = +1900{\cdot}22$$
$$-3755\ a_1 + 146825\ x_1 = -74052{\cdot}35$$
$$a_1 = +0^s{\cdot}172, \quad x_1 = -0^s{\cdot}500.$$

2·3 Magnitude Star.

		R.A. s	$\sqrt{\omega}$	C.−O. s
1	$a_2 - 120\ x_2 =$	55·56	1	−0·64
4	$a_2 - 40\ x_2 =$	18·50	3	−0·30
5	$a_2 - 37\ x_2 =$	16·86	5	−0·04
6	$a_2 - 30\ x_2 =$	13·38	6	+0·23
7	$a_2 - 10\ x_2 =$	4·57	2	−0·14
8	$a_2 - 0\ x_2 =$	0·00	4	−0·16
11	$a_2 + 5\ x_2 =$	−2·33	2	−0·13

$$95\ a_2 - 2505\ x_2 = 1134{\cdot}20$$
$$-2505\ a_2 + 95925\ x_2 = -43602{\cdot}50$$
$$a_2 = -0^s{\cdot}164, \quad x_2 = -0^s{\cdot}459.$$

The following are the equations of condition in N.P.D. :—

1st Magnitude Star.

		N.P.D. s	$\sqrt{\omega}$	C.−O.
1	$d_1 - 120\ y_1 =$	84·13	1	−23·67
2	$d_1 - 45\ y_1 =$	22·99	5	− 1·15
3	$d_1 - 40\ y_1 =$	19·17	4	+ 0·09
4	$d_1 - 40\ y_1 =$	16·39	3	+ 2·87
5	$d_1 - 37\ y_1 =$	16·65	4	+ 1·07
6	$d_1 - 30\ y_1 =$	10·91	5	+ 3·20
7	$d_1 - 10\ y_1 =$	4·50	1	− 0·69
8	$d_1 - 0\ y_1 =$	0·00	4	− 1·34
9	$d_1 + y_1 =$	−0·08	5	− 1·78
10	$d_1 + 2y_1 =$	−1·03	2	− 1·34

$$138\ d_1 - 3564\ y_1 = 1650{\cdot}64$$
$$-3564\ d_1 + 149570\ y_1 = -72223{\cdot}09$$
$$d_1 = -1''{\cdot}34, \quad y_1 = -0''{\cdot}515$$

2·3 Magnitude Star.

		$\sqrt{\omega}$	C.−O.
1	$d_2 - 120\ y_2 = 110{\cdot}37$	1	+ 19·42
2	$d_2 - 45\ y_2 = 51{\cdot}53$	5	− 1·39
4	$d_2 - 40\ y_2 = 45{\cdot}81$	3	− 0·98
5	$d_2 - 37\ y_2 = 41{\cdot}49$	4	+ 0·15
6	$d_2 - 30\ y_2 = 34{\cdot}83$	5	− 0·62
7	$d_2 - 10\ y_2 = 13{\cdot}87$	2	− 0·90
8	$d_2 - 0\ y_2 = 0{\cdot}00$	3	+ 2·35
9	$d_2 + y_2 = 0{\cdot}55$	5	+ 0·74
10	$d_2 + 2\ y_2 = -0{\cdot}05$	2	+ 0·28

$$118\ d_2 - 2954\ y_2 = 3414{\cdot}53$$

$$-2954\ d_2 + 124270\ y_2 = 138933{\cdot}28$$

$$d_2 = +2''{\cdot}35, \quad y_2 = -1''{\cdot}062$$

The values of the proper motions of the principal star agree closely with the adopted *common* proper motions of the Melbourne Catalogue. The means of the proper motions of the two stars agree closely with the adopted *common* proper motions of the Cape Catalogue.

If, for clearness of conception of the differences between these proper motions, especially in N.P.D., we place side by side the proper motions that would result from a comparison of the last group with each of the other groups whose epoch differs from its epoch by more than ten years, we have as follows :—

Proper Motions in N.P.D.

	1750.	1825.	1830.	1833.	1840.	1860.
	"	"	"	"	"	"
1 Mag *	−0·698	−0·511	−0·481 / −0·412	−0·453	−0·373	−0·461
2·3 Mag *	−0·905	−1·098	−1·092	−1·065	−1·090	−1·160
Mean P.M.	−0·802	−0·804	−0·770	−0·759	−0·732	−0·810

If therefore we attach the slightest weight to Lacaille's observations, the physical connexion of the two stars is at once established, and the course adopted in the Cape Catalogue is sensibly correct. But if this physical connexion is not admitted, the adoption of a common proper motion of $-0''{\cdot}50$ in N.P.D. for the two stars is certainly not satisfactory. The adopted proper motion should be $-0''{\cdot}52$ for the 1st magnitude star, and $-1''{\cdot}06$ for the 2·3 magnitude star. An inspection, however, of the residuals shows, I venture to think, that the assumption of a constant proper motion for either star is not a true assumption, and that the physical connexion of the system must be admitted.

I therefore pass to the second assumption. If m_1 and m_2 denote the masses of the two stars, we may show that

$$\frac{m_1}{m_1+m_2}x_1 + \frac{m_2}{m_1+m_2}x^2 \text{ and } \frac{m_1}{m_1+m_2}y_1 + \frac{m_2}{m_1+m_2}y_2$$

are constant when terms of the second order are neglected. To the same order of approximation these expressions in fact denote the proper motions of the centre of gravity of the system in R.A. and N.P.D. If the data were sufficiently accurate and well distributed, it should be possible to infer the ratio of the masses $m_1 : m_2$ from the condition that this ratio rendered the proper motions of the centre of gravity constant. The data at present available are not perhaps sufficient for such a delicate inquiry, but it will be seen that an assumption of equality between the masses does render the proper motions of the centre of gravity very accordant. As this assumption appears to satisfy the conditions better than one dependent upon their brightness, I have provisionally adopted it.

Assuming therefore $m_1 = m_2$, and denoting the R.A. and N.P.D. of the centre of gravity at the epoch 1870 by

$$14^h\ 30^m\ 47^s{\cdot}285 + a$$
$$150^\circ\ 17'\ 48''{\cdot}81 + d$$

and the proper motions of the centre of gravity by x and y, we have the following equations of condition.

R.A. Observations.

Epoch.		$\sqrt{\omega}$	C.−O.
	s		s
1750	$a - 120\,x = 56{\cdot}63$	1	+0·56
1830	$a - 40\,x = 19{\cdot}49$	$\sqrt{5}$	−0·38
1833	$a - 37\,x = 17{\cdot}84$	$\sqrt{13}$	−0·16
1840	$a - 30\,x = 14{\cdot}28$	$\sqrt{36}$	+0·07
1860	$a - 10\,x = 4{\cdot}87$	1	−0·04
1870	$a - 0\,x = 0{\cdot}00$	$\sqrt{8}$	+0·07
1875	$a + 5\,x = -2{\cdot}43$	$\sqrt{2}$	+0·12

From which we derive the following equations for the determination of a and x:

$$66\,a - 1881\,x = 900{\cdot}09$$
$$-1881\,a + 72747\,x = -34770{\cdot}04;$$

which give:

$$a = +0^s{\cdot}072$$
$$x = -0^s{\cdot}476.$$

It is with these values that the residuals given in the column (C.−O.) have been formed.

N.P.D. Observations.

Epoch.		$\sqrt{\omega}$	C.−O.
	"		"
1750	$d - 120\,y = 97{\cdot}25$	1	−0·28
1825	$d - 45\,y = 37{\cdot}26$	6	−0·67
1830	$d - 40\,y = 32{\cdot}49$	2	+0·08
1833	$d - 37\,y = 29{\cdot}07$	3	+1·08
1840	$d - 30\,y = 22{\cdot}88$	4	+1·64
1860	$d - 10\,y = 9{\cdot}19$	2	−0·77
1870	$d - 0\,y = 0{\cdot}00$	3	+0·37
1871	$d + y = 0{\cdot}24$	4	−0·68
1872	$d + 2\,y = -0{\cdot}54$	1	−0·70

The equations for the determination of d and y are:

$$96\,d - 2735\,y = 2236{\cdot}34$$
$$-2735\,d + 120841\,y = -98257{\cdot}15$$

which give:

$$d = +0''{\cdot}366$$
$$y = -0''{\cdot}805$$

These values have been used in the formation of the residual errors.

The residuals for the N.P.D. observations about 1833–1840 are large; but it may be mentioned that the observations in the groups 1833–1840 were made with the same instrument, and that, although the adopted zenith-points have been determined from reflexion and direct observations of stars, and that the observations of α *Centauri* must, from their number, have had considerable weight in the formation of the adopted zenith-points, yet a discordance of about 1″·6 still exists between the direct and reflexion results for α *Centauri*. The residuals are, however, certainly much more satisfactory, especially in N.P.D., than the residual errors resulting from the assumption of the independence of the two stars. It is not, therefore, the use of Lacaille's observations which give rise to the large proper motion in N.P.D. adopted in the Cape Catalogue, for but little weight has been assigned them. If we compare the last Cape observation group for 1872 with the earlier observations, the following would be the separate values of the common proper motion in N.P.D.:

1750.	1825.	1830.	1833.	1840.	1860.
−0″·801	−0·804	−0·786	−0·759	−0·732	+0·810

These results are as accordant as could be expected, and appear to justify as a close approximation to the truth the

assumption of $m_1 = m_2$. It will be seen that the proper motions deduced from the centre of gravity of the system, or the common proper motions of the two stars, viz., $-0^s.476$ and $-0''.805$, are nearly the same as those adopted in the Cape Catalogue, 1860. If common proper motions be adopted for the two stars, the results of the Cape Catalogue are substantially correct.

Occultation of the Pleiades observed at Madras, on January 7th, 1876.

(*Communicated by N. R. Pogson, Esq., Director of the Observatory*).

Star.	Phenomenon.	Madras M.T. h m s	Observer.
16 Tauri (Celæno)	Disap.	12 43 50·9	N.R.P.
" " "	"	12 43 51·0	E.I.P.
17 Tauri (Electra)	"	12 47 28·8	N.R.P.
" " "	"	12 47 29·1	E.I.P.
19 Tauri (Taygeta)	"	13 7 43·1	N.R.P.
" " "	"	13 7 43·1	E.I.P.
20 Tauri (Maia)	"	13 14 9·6	N.R.P.
" " "	"	13 14 18·0	E.I.P.
Bessel's Anonyma 8	"	13 23 1·1	N.R.P.
" " "	"	13 23 1·5	E.I.P.
Bessel's Anonyma 9	"	13 24 14·7	N.R.P.
Bessel's Anonyma 10	"	13 28 3·7	E.I.P.
22 Tauri	"	13 35 47·3	N.R.P.
" "	"	13 35 47·0	E.I.P.
21 Tauri (Asterope)	"	13 40 27·1	N.R.P.
" " "	"	13 40 26·7	E.I.P.
Bessel's Anonyma 12	"	13 54 30·0	N.R.P.
" " "	"	13 54 32·5	E.I.P.
24 Tauri	"	13 58 49·2	N.R.P.
η Tauri (Alcyone)	"	14 3 48·3	N.R.P.
" " "	"	14 3 47·8	E.I.P.
20 Tauri (Maia)	Reap.	14 12 27·2	N.R.P.
" " "	"	14 12 32·4	E.I.P.
Bessel's Anonyma 29	Disap.	14 19 10·3	N.R.P.
η Tauri (Alcyone)	Reap.	14 38 24·3	N.R.P.
" " "	"	14 38 15·2	E.I.P.

The preceding Observations were made, as initialled, by Mr. Norman R. Pogson, with the Smythian 5-ft. telescope, by Tulley,

power 74; and by his daughter and chief assistant, Miss E. Isis Pogson, with the Lerebours & Secretans' Equatoreal, power 63. The former used a mean-time chronometer; the latter a sidereal clock. All the disappearances at the Moon's dark limb were sudden and satisfactory, but an error of ten seconds, due to miscounting, appears to have been made by one of the Observers in the case of *Maia*. The Moon set at $15^h\ 3^m$, and the sky being hazy near the horizon, the reappearances were very uncertain, especially that of *Alcyone*, which was certainly not noted by N. R. P. until much too late. The broad hyperbolic boundary of the nebulosity in the south-west of the *Pleiades* is always easily traceable here with the Lerebours' Equatoreal, and the contrast between the greyish-white sky-ground around and *s p* of *Merope* with the deep blue background near *Alcyone* is very striking on a fine moonless night. In the absence of moonlight, besides the six well-known and conspicuous stars, *Celæno*, the combined light of *Asterope* and 22 *Tauri* as one object, and *Pleione*, distinct from *Atlas*, are all clearly discernible to any tolerably good unaided sight which is up to seeing *Uranus*, *Vesta* in opposition, 13 *Messier* in *Hercules*, or separating 4 and 5 *Lyræ* without optical aid.

Micrometer-Measures of Saturn's Satellites, made at the Royal Observatory, Greenwich, in the year 1875.

(*Communicated by the Astronomer Royal.*)

The observations were made with the Great Equatoreal, using a power of 285 applied to the Position Micrometer. The measures of distance are the means of the distances from the satellite to the near and distant limbs of *Saturn*, two moveable webs being brought simultaneously on the satellite and on each limb of *Saturn* alternately; the position-angles prior to September 21 are the means of those found by making a fixed web (at right angles to the other), bisect the satellite, and touch the limb of *Saturn* on the two sides alternately. On September 21 two webs were inserted parallel to the fixed web, and at such a distance apart that the two new webs could be made to touch the limbs of *Saturn* at the same time that the middle web bisected the satellite; each of the position-angles given is the mean of those found in reversed positions of the micrometer, and is measured from the N. point in the direction N.E.S.W. The observations were usually made with the illuminated wires in a dark field.

The initials W. C., M., and J., are those of Messrs. Christie, Maunder and Jenkins.

1875.	Greenwich Sidereal Time of Obs. of Distance.	Observed Distance.	Greenwich Sidereal Time of Obs. of Position-Angle.	Observed Position-Angle.	Observer.
		Iapetus.			
	h m s	′ ″	h m s	° ′	
Sept. 14	20 45 45	3 11·50	20 54 30	94 49	W. C.
17	20 37 40	1 8·19	20 49 45	106 42	J.
„	22 31 40	1 4·18	22 37 25	109 13	
20	20 17 10	1 5·25	20 24 50	252 41	W. C.
29	20 58 5	6 31·98	21 3 20	268 7	M.
„	21 15 55	6 34·70			
Oct. 2	22 1 10	7 51·73	21 30 15	269 22	J.
5	21 52 15	8 36·44	22 20 40	269 41	„
„	22 41 45	8 37·34			
6	20 22 40	8 45·43	21 10 15	270 20	„
„	21 14 20	8 46·94			
11	21 42 45	8 55·14	21 48 15	270 50	M.
„	22 0 25	8 50·14			
12	21 49 20	8 39·13	21 49 56	270 41	W. C.
„	22 0 55	8 40·41			
16	20 49 5	7 32·46	20 58 25	271 53	J.
„	20 58 45	7 34·02			
21	21 42 35	5 6·68	21 44 35	273 45	
25	21 37 0	2 38·90	21 54 50	277 26	
„	21 53 40	2 38·54			
Nov. 4	21 47 10	3 59·48	22 0 15	86 23	„
„	21 59 15	4 2·85			
8	22 18 55	5 29·83	22 26 20	85 38	„
„	22 25 50	5 30·02			
		Titan.			
Sept. 14	19 39 45	2 38·88	19 46 20	105 54	W. C.
„	19 53 15	2 37·21	19 58 35	105 49	
15	21 31 25	1 45·41	21 37 30	119 17	J.
„	22 26 15	1 45·26	22 30 45	118 23	
17	19 53 15	56·21	19 56 5	224 44	„
„	21 56 50	59·95	21 59 50	230 32	
18	21 24 10	1 53·18	21 31 10	257 30	W. C.
20	21 0 5	2 59·37	20 55 20	273 58	„
27			21 15 50	89 38	M.

1875.	Greenwich Sidereal Time of Obs. of Distance. h m s	Observed Distance. ′ ″	Greenwich Sidereal Time of Obs. of Position-Angle. h m s	Observed Position-Angle. °	Observer.
Sept. 28	22 2 10	3 8·42			
29	20 24 55	3 3·95	20 36 5	100 18	M.
,,	20 47 50	3 3·13			
30	20 33 55	2 33·51	20 46 25	106 35	J.
,,	20 48 25	2 32·68			
Oct. 2	20 33 0	55·59	21 14 10	152 47	,,
,,	21 49 50	52·20			
5	21 35 0	2 34·75	21 59 50	269 24	,,
,,	22 15 15	2 38·83			
6	20 15 25	2 55·93	20 41 5	275 22	,,
,,	20 59 40	2 56·25			
11	21 27 35	1 12·73	22 0 15	68 33	M.
,,	22 35 20	1 16·23			
12	21 5 0	2 4·86	21 51 45	81 22	W. C.
,,	22 41 55	2 8·75			
16	21 42 40	2 27·02	21 49 10	108 0	J.
,,	21 49 10	2 28·28			
21	21 36 45	2 32·12	21 38 50	268 32	,,
25	20 57 35	1 28·33	21 3 45	302 11	,,
,,	21 4 0	1 28·03			
Nov. 4	21 22 10	58·70	21 30 55	229 41	,,
,,	21 30 25	58·95			
8	21 42 10	2 41·42	21 57 40	80 53	,,
,,	22 6 5	2 42·40			
15	21 28 30	2 55·83	21 38 5	95 46	M.
,,	21 51 35	2 33·01)			
		Rhea.			
Sept. 14	20 10 5	46·29	20 20 30	76 18	W. C.
,,	22 47 0	55·22	22 37 0	79 34	
15	21 20 15	1 14·01	21 25 35	102 40	J.
,,	22 13 5	1 11·68	22 19 40	101 49	
17	19 40 20	1 21·71	19 45 30	275 24	,,
,,	21 45 20	1 23·06	21 50 0	278 49	
18	21 3 40	21·45	21 16 0	340 48	W. C.
20	20 49 0	42·15	20 43 55	119 53	,,
27			20 49 5	326 30	M.
28	21 55 10	1 16·02	21 [illegible] 40	[illegible] 0	[illegible]

1875.	Greenwich Sidereal Time of Obs. of Distance. h m s	Observed Distance. "	Greenwich Sidereal Time of Obs. of Position-Angle. h m s	Observed Position-Angle. ° ′	Observer.
Sept. 29	20 16 30	48·21	20 30 45	116 5	M.
,,	20 39 10	49·53			
30	21 49 55	1 2·34	21 55 20	263 56	J.
Oct. 2	20 18 5	36·04	21 2 45	70 18	,,
,,	21 39 45	41·78			
5	21 28 50	1 17·97	21 52 30	274 21	,,
,,	22 8 55	1 19·48			
6	20 6 15	22·16	20 32 45	313 32	,,
,,	20 51 5	29·00			
11	21 12 10	34·32	21 49 30	69 24	M.
,,	22 30 5	39·09			
12	21 12 30	1 16·49	21 48 50	99 45	W. C.
,,	22 28 40	1 15·75			
16	20 23 40	1 5·51	20 31 30	86 45	J.
,,	20 37 10	1 7·35			
21	21 31 25	1 17·25	21 33 35	97 56	,,
25	20 44 35	1 3·07	20 50 45	85 32	,,
,,	20 51 5	1 3·08			
Nov. 4	21 35 55	57·07	21 40 35	107 54	,,
,,	21 41 5	57·58			
8	21 47 25	2 13·59	21 56 45	95 0	,,
,,	21 56 50	1 55·24			
15	21 37 10	1 10·75	21 46 55	285 4	M.
,,	21 59 45	1 11·07			
		Dione.			
Sept. 14	21 6 55	24·98	21 13 25	120 30	W. C.
,,	22 31 0	23·02	22 22 0	129 11	
17	21 10 5	14·98	21 18 55	167 24	J.
18	21 40 5	38·83	21 50 55	292 58	W. C.
20	20 34 40	54·78	20 28 30	259 7	,,
29	21 59 0	35·84	22 2 45	294 15	M.
,,	22 5 25	33·63			
30	21 14 20	56·19	21 35 20	97 13	J.
,,	21 33 50	56·05			
Oct. 5	21 43 0	30·61	22 10 30	78 28	,,
,,	22 27 45	33·30			

1875.	Greenwich Sidereal Time of Obs. of Distance. h m s	Observed Distance. "	Greenwich Sidereal Time of Obs. of Position-Angle. h m s	Observed Position-Angle. ° ′	Observer.
Oct. 6	20 39 30	26·90	21 10 30	120 57	J.
,,	21 35 55	23·67			
11	21 6 10	54·12	21 40 20	98 24	M.
,,	22 22 50	57·32			
12	21 34 25	42·54	21 50 55	265 29	W. C.
,,	22 12 0	45·43			
16	21 14 10	32·44	21 25 10	77 56	J.
,,	21 27 0	33·16			
21	21 50 40	32·62	21 53 55	299 55	,,
25	21 12 20	43·28	21 20 55	93 49	,,
,,	21 21 25	44·28			

Tethys.

Sept. 14	21 21 40	22·38	21 29 30	254 51	W. C.
,,	21 47 45	23·92	21 39 45	255 5	
17	20 4 45	33·37	20 10 15	85 27	J.
,,	22 8 40	39·14	22 13 40	90 14	
18	22 3 40	24·36	22 16 10	272 38	W. C.
20	20 0 25	44·88	20 9 15	273 23	,,
,,	20 4 55	47·48			
Oct. 2	21 19 40	23·08	21 23 0	68 54	J.
5	21 22 0	39·53	21 46 20	270 51	,,
,,	22 1 20	40·99			
6	20 30 50	41·99	21 1 40	90 32	,,
,,	21 27 30	43·13			
11	21 18 45	39·32	21 42 50	286 13	M.
,,	22 11 50	37·50			
12	21 21 45	33·55	21 20 0	107 14	W. C.
21	21 25 20	32·17	21 50 35	85 10	J.
,,	22 4 5	30·24			
25	22 12 25	38·77	22 21 30	111 13	,,
,,	22 20 25	39·36			
Nov. 8	21 37 15	33·16	22 39 25	266 17	,,
,,	21 42 10	36·40			
15	22 45 45	29·91	22 46 15	110 12	M.
,,	22 51 0	27·58			

Notes.

September 14. *Saturn* was very tremulous and diffused at times. *Iapetus*, *Dione*, and *Tethys* were very faint, and were observed in a slightly illuminated field. The belt of *Saturn* was very conspicuous, but the colour was scarcely so marked as when seen a week previously. The curvature of the shadow of the ball on the ring was very well seen, the definition being occasionally very good.

September 15 and 17. The measures were made with great difficulty.

September 18. Sky very hazy; the observations were difficult, but the definition of the planet was very good for a few moments at a time. The belt was again very conspicuous and reddish, and the planet appeared brighter than the ring where it crossed the ball. The shadow on the ring was curved as on September 14.

September 20. Sky rather hazy.

September 28. *Saturn* very tremulous.

September 29. *Dione* was exceedingly faint and difficult to measure, and was only seen at long intervals. All the observations were made with the wires illuminated on a dark field. *Saturn* was occasionally well defined, but in general the limbs were diffused.

September 30. The planet tremulous.

October 2. At the first observation of *Titan* the image of *Saturn* was tremulous, otherwise it was very good.

October 5. The planet tremulous at the second observation of *Titan*; *Dione* very faint.

October 6. *Dione* and *Tethys* very faint.

October 16. The first measures of *Titan*, *Rhea*, and *Dione* were made under favourable circumstances; but before the second series of measures the limbs of *Saturn* became very tremulous, and *Tethys*, especially, was difficult to measure owing to its faintness.

October 12. *Iapetus*, *Dione*, and *Tethys* faint. The illuminated wires on a dark field were used throughout the observations.

October 16. *Saturn* very tremulous; *Dione* very faint.

October 17. *Dione* very faint; the image of the planet good.

October 25. Sky rather misty; *Dione* and *Tethys* were very faint, and the planet's limbs much diffused.

November 4. Sky rather hazy; *Iapetus* faint.

November 8. *Iapetus* and *Tethys* faint; *Titan* and *Rhea* observed through thin cloud.

November 15. *Tethys* very faint; *Saturn* also was faint, but free from tremor in the first series of measures. In the second series the planet was diffused and tremulous.

Observations of the November Meteors, made at the Royal Observatory, Greenwich, in the Year 1875.

(*Communicated by the Astronomer Royal.*)

Greenwich Mean Solar Time 1875.	Apparent size of Meteor in Star Magnitude.	Observer.	Path of Meteor with reference to the Stars.	No. for Reference.
d h m s				
Nov. 13 13 39 10±	>1	E.	From region of upper part of *Cancer* moved towards zenith. Observed through a break in the clouds. [Very cloudy night throughout.]	1
14 12 53 50	>1	N.	Moved from direction of δ *Draconis* towards α *Cygni*. Estimated length of path =6°	2
„ 13 2 40	2	G.	Shot downwards from α *Ursæ Majoris*, and disappeared between γ and δ *Ursæ Majoris*, but nearer to δ *Ursæ Majoris*	3
„ 13 48 38	>1	N.	From a point about 5° below γ *Ursæ Majoris* fell vertically, passing almost midway between η *Ursæ Majoris* and α *Canum Venaticorum*. Estimated length of path = 16°	4
„ 14 14 20	1	G.	Shot from α *Orionis* towards *Sirius*	5
„ 14 31 27	2	N.	From direction of ε *Leonis* passed across ζ *Hydræ*. Estimated length of path = 5°	6
„ 14 32 39	2	N.	Passed across α *Orionis* towards γ *Orionis*. Estimated length of path =6°	7
„ 14 46 13	1	N.	Appeared at a point about 5° below μ *Ursæ Majoris* and about 8° to right of ψ *Ursæ Majoris*. [Very short motion = 0°·5.]	8
„ 14 46 49	1	N.	From direction of γ *Ursæ Minoris* passed across ι *Draconis*. Estimated length of path =10°	9
„ 14 48 35	2	N.	From direction of δ *Leonis* passed about 10° below α *Canum Venaticorum*. Estimated length of path =12°	10
„ 14 49 17	1	N.	From a point about 10° below *Regulus* fell at an angle of 30° from vertical to left: disappeared about 15° to left of α *Hydræ*	11
„ 15 9 41	1	G.	Shot from about midway between α and β *Ursæ Majoris* towards κ *Draconis*	12

Greenwich Mean Solar Time 1875.	Apparent size of Meteor in Star Magnitude.	Observer.	Path of Meteor with reference to the Stars.	No. for Reference.
d h m s				
Nov. 14 15 15 1	2	G.	Appeared near α *Orionis*, and disappeared near β *Orionis*	13
„ 15 21 36	1	G.	Shot from θ *Geminorum* towards *Castor*	14
„ 15 26 51	1	G.	Shot from ϵ *Ursæ Majoris* towards η *Ursæ Majoris*	15
„ 15 30 57	2	N.	Moved from direction of a point midway between η *Ursæ Majoris* and α *Canum Venaticorum* towards γ *Boötis*. Estimated length of path = 5°	16
„ 15 36 40	2	N.	From direction of γ *Ursæ Majoris* towards ψ *Ursæ Majoris*. Estimated length of path = 5°	17
„ 15 41 34	>1	N.	Center of path about 10° to right of *Sirius*, moving from direction of α *Cancri* towards ϵ *Canis Majoris*. Estimated length of path = 8°	18
„ 15 58 52	1	N.	Center of path 15° below α *Hydræ*, moving from direction of *Regulus*. Estimated length of path = 5°	19
„ 16 3 7	3	G.	Shot from γ *Geminorum*, at an angle of 45° towards west	20
„ 16 9 33	2	G.	Shot from *Castor* towards γ *Geminorum*	21
„ 16 11 24	1	G.	Shot from *Aldebaran* towards γ *Orionis*	22
„ 16 14 22	2	G.	Shot from *Procyon* towards *Sirius*	23
„ 16 24 32	1	G.	Shot from *Sirius* towards β *Canis Majoris*	24
„ 16 43 3	2	G.	Shot from ζ *Draconis* towards β *Draconis*	25
„ 16 49 3	1	N.	From direction of α *Canum Venaticorum*, passed about 2° N. of *Arcturus*. Estimated length of path = 12°	26

As regards colour, Nos. 2 and 6 were recorded as being "white"; Nos. 3 to 5 and 7 to 26 were noted as "bluish white"; Nos. 1, 4, and 18 were considered to be equal in magnitude to the planet *Jupiter*.

The meteors Nos. 1, 2, 6, 7, 10, 11, 12, 13, 18, 19, 23, and 24 were from the *Leo* radiant; probably No. 20 also. The remaining meteors were from other radiants. The observations were all made in bright moonlight, consequently only, comparatively speaking, large meteors would be seen.

The initials E., N., and G. are those of Mr. Ellis, Mr. Nash, and Mr. Greengrass.

Royal Observatory, Greenwich,
1876, *March* 8.

Abstract of Prof. Christian Mayer's (of Heidelberg) Vertheidigung neuer Beobacht. Gruendliche von Fixstern Trabanten entdeckt in der Mannheim. Sternwarte. Mannh. 1778, 8vo., pp. 308, 2 plates. By S. M. Drach, Esq.

This almost forgotten little work contains a reference to the author's first proposal at the Mannheim Academy (on 17th Oct., 1777) of observations of Binary Star Systems, before Sir W. Herschel's discovery of *Uranus*. I first heard of it in Mädler's *Populär Astron.* (*Doppelst.*, Art. 205, ed. 1841). The Royal Society, and British Museum (1395 e), each possess a copy. Berlin has not yielded me a copy for presentation to the Royal Astronomical Society, and my two MS. versions, given to Mr. Williams for our Society, seem to have been lost in the confusion of moving—a fate that also overtook Reich's first Cavendish Experiments in 1828–9, and possibly other fugitive tracts.

The author was furnished with London-made instruments, was supported in his views by Maskelyne and La Caille, versus the vituperative opposition of Father Hell of Vienna. The first portion is a reprint of newspaper articles—Mayer, in *Mannheim Zeitung* (No. 84, Oct. 20, 1777; Nos. 93–4, Nov. 20–24, 1777; No. 102, Dec. 22, 1777): and Hell, in *Wiener Diarium* (No. 90, Nov. 8, 1777; No. 99, Dec. 10, 1777; No. 102, Dec. 20, 1777).

The first is an account of 100 new fixed star satellites (f. ss.) observed January 30, 1776, to September 14, 1777, by Mayer and his assistant John Mezger, beginning with *Arcturus and its* 15 *Satellites* (comes).

Hell wrote in 1759 to Paris that said satellites are only small fixed stars; and that Mayer and Mezger's small variations had been noticed by Tycho Brahé.

Mayer keeps to the word *comes*; refers to Riccioli's *Almagest*, t. 1, bk. 7, ch. 3; to Flamsteed and Maskelyne, and says these diff. prop. mot. would make Sidereal Astronomy wonderfully progressive.

M. Hell sent in 1759 (1758?) to Paris a catalogue of 13 mobile fixed stars.—Tycho Brahé. See La Lande, *Astronon.*, t. 3, p. 154, No. 2573 (*Astron. instaurat. Progymnast.* An. 1610, p. 233). M. Hell's letter to La Caille, August 20, 1758, on variable latitude of 17 stars: received Mayer's writings through Mr. Brawdler, a learned Englishman. (? Bowdler, S.M.D.)

P. 42, Mayer's original Memoir, *De centum stellarum fixarum comitibus eorumque insigni usu ad determinandum motum proprium fixarum.*

At p. 49 begins the author's dissertation: that the instrument was a Bird's mural quadrant of 8 feet, fixed up in 1775, and so accurate that Bird obtained a reward of 500*l.*, enabling 3rd magnitude stars to be seen at 10 A.M.; he argues, from Saturnian satellites, on the possibility of fixed-star ones.

Thus, *Comes Arcturus* followed in 1758 in $3\frac{2}{3}^s$ time; in 1777, in 6^s time: whereby (p. 65) all the comparisons of 500 or 1,000 years between instruments of extreme degrees of perfection are avoided.

Thus, Feb. 14, 1690, Flamsteed saw *Arcturus* 3^s after its Comes (7-mag.): and 26′ 30″ N. of Comes, in April 1736, at Greenwich, *Arcturus* preceded by $1\frac{1}{2}$ to $1\frac{3}{4}^s$, and north by 24′ 55″.

In May 1765, Maskelyne made difference 4^s time.

Mayer himself, in May 1777, found it 6 to $6\frac{1}{2}^s$.

P. 71 refers to Halley's announcement of proper motions, *Phil. Trans.*, No. 355, p. 736, for 1719; but La Lande, Tob. Mayer, &c., all trod in Halley's footsteps.

P. 78. Maskelyne in 1765–77 observed Comes to *Arcturus*, *α Scorpii*, *α Aquilæ*, *α Lyræ*, *α Cygni*, *η Gemini*, *ε Lyræ*, and twelve others, which Maskelyne calls *comes fixarum*.

P. 81. Kæstner, at Göttingen, has a 6-foot Bird's mural quadrant. Maskelyne's Letter, December 1, 1777, to Meyer concurs in his views; having on August 7, 1777, seen a 6-mag. star *α Hercul.* (Extract, Latin Letter.)

P. 90. Author adds *α Centaur.* *α Hydræ*, *Castor*, *γ Virgin.* *δ Serpens.* *A Ophiuchi*, *β Sagittar.* *o Capric.* *ζ Cancri* are all double stars (*Doppelsterne*); and *α Aries* (on December 23, 1876). *Cor Caroli* (2^s, 17″); *Regulus's* (10^s, 57″5); *δ Boötis* has (8^s, 18″). The double star *Castor* has one ($3\frac{1}{2}^s$, 4″); *ν Scorp.* (2^s, 33″); *β Scorp.* ($\frac{1}{2}^s$, $17\frac{1}{2}$″); near *ε Delphin.* (2^m, 2′) is a double star (apart 1^s·8, 3 to 5″); also *γ Delph.* (1^s, 11″.); *γ Androm.* (2^s, 4″5); *δ Orion.* (0^s, 50″): *β Lyræ* (2^s, 40″); *μ Cygni* (1^s, 2″5); a double star, with a comes (15^s, 93″); a double star near *γ Pers.* one near *α Androm.*; a tri-star near *x Pisc.*; *ι Cancri* is a double star, *ε Cancri*, *γ Cygni*, *β Lyræ*, *ζ Aquarii*, *π Pisc.*

P. 107. Finds in *two* years a change in light, apparent magnitude, and distance from greater member, to be *thought of* (*bedenklich*).

P. 108. Author asks if these starlets will fade away; and if this proper motion falls on small stars; if they move rectilinearly, or circularly round the greater star as their centre of gravity, whilst the greater and higher one courses round another sun or planet? or if, *vice versâ*, these starlets as a whole force the greater one to move round them? Quotes Le Seur and Jacquier on Newton. (*Princip.* tom. iii. *Genev.* fol. 670.)

P. 112. These double stars are either, 1) the smaller are opaque ones revolving round the larger; 2) dark spheres, round which mobile suns move; 3) or both luminous, revolving round a common point of rest: exemplified in solar system.

P. 116. Recounts *new stars* seen—his observations of Comet of 1769, August–September, at St. Petersburgh (Euler's period of 340 years). P. 123, quotes Lambert and Maupertuis (*Lettr. Progr. Science*, sect. 9, fol. 400. Central Sun).

P. 133. Proves Fixstar-satellites from changeable position of Comes to principal star; from observations upon Flamsteed's

time, especially (p. 179) *Arcturus*: Anno 1690 — 3^s, 26′ 30″ to 1778, + $5^{s\cdot}$ 67, and 23′ 33″·7. P. 176–9, details Plate 1.

Then follows another refutation of Father Hell, with a detailed description of the Mannheim Bird's mural quadrant, and observations therewith.

He then (p. 206) explains the other diagrams of Plate 2; and this is followed by further anti-Hellite arguments, with extracts from La Lande,* Tycho Brahé, Halley, ending with Mayer's insisting on his method being new, *truly useful and excellent*; so that by the *differences* of motions of stars to each other, we will sooner acquire a notion of their movements, than by the old method of contemplating the absolute displacements from a common fixed point.

14 *Feb.* 1876.

Preliminary Note on Photographing the Least Refracted Portion of the Solar Spectrum.

By Capt. W. de W. Abney, R.E.

Within the last two years there have been many attempts made to photograph the least refrangible rays of the spectrum; and though stated to have been accomplished by the elder Draper on a daguerreotype plate in the early days of photography, yet there is reason to believe that this was effected by the reversing action of these rays on slightly exposed sensitive iodide of silver, and that really no direct photographic impression had been obtained till Dr. Vogel published an account of a method for effecting this object in 1874. More recently, Capt. Waterhouse, of the Bengal Staff Corps, has followed up Dr. Vogel's researches, and with a larger share of success than the originator. Both these gentlemen have had resort to aniline dyes of varying colour, using it with the preservative to the plate; and they state that the red end of the spectrum is most sensitive when a red dye (naphthaline) or rosine is employed, and propound generally that the rays that can be photographed are dependent on the colour of the dyes employed: that colour, and not the ingredient added to the sensitive silver salt, is the essential.

Lately I have had occasion to investigate the subject, and have met with such good results that I desire to communicate a preliminary Note to the Society. I have carefully repeated the previous experiments of Vogel and Waterhouse, and only attained partial success with them, though there was sufficient evidence to show that with the dyes the desired end would be attained. Looking more carefully into the chemistry of the

* *Vide* La Lande's *Bibliographia Astronomica*, p. 565. Refers to *Journal des Savans*, Feb. 1779.

question, however, it struck me that the same results might be obtained by other means than colour, and experiments were undertaken with a large series of gum resins and other oxidised hydrocarbons (added to ordinary collodion), some colourless and some not. With every gum resin was obtained a considerable extension of the photographic spectrum below the lines *b*, and at length I procured a resin forming with silver a perfectly white compound that seems to be capable of taking an image far below the line A. At present, I find that the longer the exposure given, the greater the length of the spectrum impressed, and I believe that, with patience, a very large part of the absorption-lines lying beyond that point may be registered, as I have obtained impressions which are constant in each plate exposed. The past winter has been of a most unsatisfactory nature for this kind of work, and it is only at long intervals that I have been enabled to catch the Sun for this purpose. I am earnestly looking forward to brighter sunshine, when I have not the least doubt that I shall obtain sharp fiduciary lines in the ultra-red. The addition of any colour to the preparations has been anything but beneficial, retarding the action greatly; and, from what is apparent, the virtue of the dyes used consists simply in the fact that they are hydrocarbons of some kind, probably combined with the faint traces of silver always left in the film of the sensitive plate.

Experiments with potassium bichromate have also been undertaken; and the result shows that (where partially insolated) the rays which usually have no effect on the sensitive compound are capable of continuing the action set up, as I pointed out in the year 1872. Iron and uranium have also yielded prolonged spectra.

The first experiments were carried out with a single prism of 60°, and a lens to the camera of 4-feet focus; the later experiments have been made with a direct-vision spectroscope of 9 prisms, being equivalent to about three single prisms, and with 4 prisms in battery. The same camera and object-glass have been employed.

Observations of Coggia's Comet. By G. H. With, Esq.

During July 1874 I made numerous observations of Coggia's Comet, with Newtonian telescopes furnished with silvered-glass specula, of aperture varying from $8\frac{1}{2}$ to $12\frac{1}{4}$ inches.

Notes of *three* of these observations may not prove uninteresting to the Fellows of the Society.

I also send copies of three sketches, made within a few hours of the time of each observation.

July 8, 1874, 10.30 P.M. I observed Coggia's Comet with an $8\frac{1}{2}$-in. aperture Newtonian, furnished with a silvered-glass speculum, and power $125+$. The nucleus was small and bright, with a fan-shaped jet of about $130°+$ issuing from it. The envelope and coma were sharply defined at their outer edges; the central axis of the coma appeared almost black, with a fairly defined boundary.

I would direct special attention to the following fact:

A remarkable oscillatory motion of the fan-shaped jet, upon the nucleus as a centre, occurred at intervals of from 3 to 8 seconds+.

The fan seemed to "tilt over" from the preceding towards the following side, and then, for an instant, appeared sharply defined and fibrous in structure. Suddenly it became nebulous, all appearance of structure vanished, and the outline became merged in the surrounding matter.

At the moment of this change a pulsation was transmitted from the head through the coma, as though luminous vapour had been projected from the former into the latter.

These phenomena were observed many times during the evening, both by myself and a well-trained optical assistant.

They were not "glimpsed," but easily and most unmistakably seen.

July 11, 10.30 P.M. $12\frac{1}{4}$-in. speculum; powers 90 to $300+$. A singular change had taken place in the shape of the jet proceeding from the nucleus. A spiral tendency appeared to have been developed in it; the fibrous structure was most distinct; also the width of the coma had increased. No oscillation as on the 8th was perceptible.

July 14, 1874, 10.30 P.M. (*see sketch*). $8\frac{1}{2}$-in. speculum; powers 125 to $300+$. On this occasion the nucleus was very bright and sharply defined.

The jet had resumed its fan-like shape, but was now enriched with a broad, well-defined border of condensed light. The envelope extended only a very small distance beyond the arc of the fan, which included, as on July 8, about 135°.

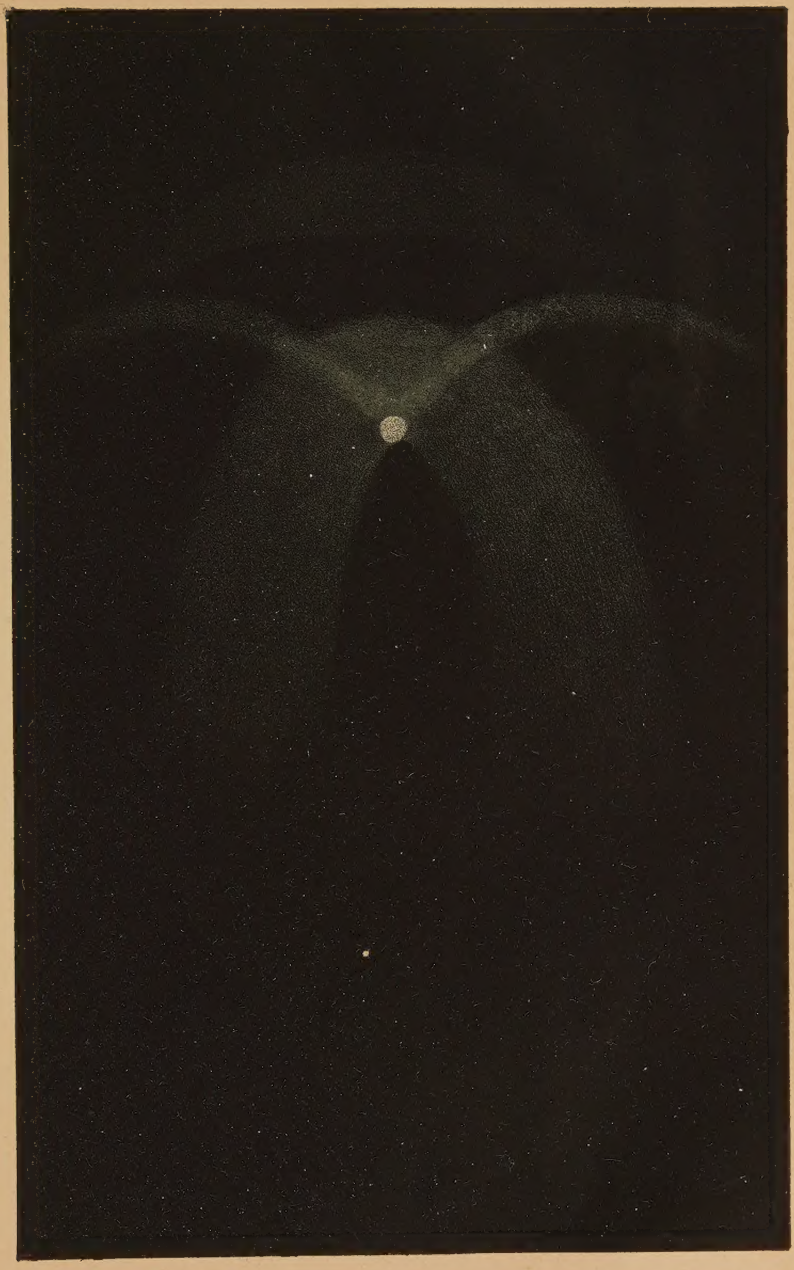
But above the primary envelope, and quite separate from it, were three faintly luminous, flocculent clouds of cometary matter symmetrically arranged and well defined in shape, though fading into blackness at the edges.

After this evening the observations presented no points of special interest. The oscillation of the jet was seen only on the 8th.

Hereford, 1875, Nov.

COGGIA'S COMET. 1874. JULY 12. 11 P.M.

as drawn by Mrs Newall.



COGGIA'S COMET. 1874. JULY 14. 10 P.M.

as drawn by Mrs Newall.

Extract from a Letter addressed to Mr. Ranyard on Drawings of Coggia's Comet. By R. S. Newall, Esq.

As you think the drawings of Coggia's Comet by Mrs. Newall, which were made at Ferndene on July 12 and 14, 1874, would be worth recording in the *Monthly Notices*, I beg to send them to you with the following remarks :—

I had observed the Comet on June 7 and 8. It was then a luminous mass with a distinct stellar nucleus. I had not another opportunity of seeing it till the night of Sunday, July 12, when we had a clear sky, but accompanied with the disadvantage of our usual, at that time of the year, highly illumined northern sky.

Fig. 1 is a very fair representation of what we saw. The nucleus was very bright, with a disk tolerably well defined. In front of the nucleus was a fan-shaped light, which seemed to arise from the overlapping, or duplication of the two tails, which streamed away behind for a length of about 15°, forming, as it were, two luminous veils, delicate, transparent, and flickering, leaving between them a black space, well defined up to the nucleus. The edges of these tails appeared to be brighter than the middle part, and crossing over the nucleus they formed the sides of the fan, the outside edges, also crossing over, formed the top of the fan and head of the comet. In front of this was another covering, semicircular and brightest in the preceding part, and in front of that was again another fainter envelope or cloud. The colour of the comet was greenish yellow. A small star was visible through the tail.

The next view we got of the Comet was on Tuesday, July 14, when a wonderful change had taken place. This is extremely well represented by fig. 2, which was made by Mrs. Newall, and was so exact that I did not touch it. Here the nucleus is still very distinct. The two streams of the tail have separated and become shorter, leaving a wider dark space between, while from the two corners of the fan proceed two anthenæ, which appear to be projections of the inner sides of the tails, and preceding these is still a luminous cloud.

On both nights the effect of motion was conveyed in a remarkable manner by the flickering of the tail.

Note on the Duplicate Structure of Coggia's Comet.

By A. C. Ranyard, Esq.

The drawings that were made of Coggia's Comet during the early part of July 1874 show that although there was but one small almost stellar nucleus there were two sets of parabolic

envelopes situated side by side, and apparently overlapping one another just in front of the nucleus. These were well shown in the drawings made by Mr. Huggins and Mr. Christie. They are also to be seen in Mrs. Newall's drawing No. 1, and they were described by Mr. Lockyer in a letter, published in *The Times* of July 16, on the structure of the Comet.

On July 14—the last evening that the head of the Comet was visible in England—Mr. With, at Hereford, and Mrs. Newall, at Gateshead, appear to have observed, in addition to the above-mentioned double structure, two faint parabolic arcs situated symmetrically with regard to the nucleus, but with their axes separated by a much greater interval than that between the other, and smaller, arcs.

A lateral disruption was evidently going on in the structure of the Comet: not so complete as the disruption which took place in Biela's Comet during its approach to perihelion in 1846, for in this instance the nucleus still remained single, and the distance between the axes of the inner arcs remained about the same as before. After Coggia's Comet had passed through perihelion, and when it was again visible in the Southern hemisphere, the inner duplicate structure was still visible, but the outer arcs had been dissipated. Possibly, such disruptions in the structure of comets are more common than has been suspected. Kepler seems to have believed that the Comet of 1618 split into two, for which Pingre, in his *Cométographie*, vol. ii. p. 7, ridicules him. He says: "Kepler a soupçonné que ce n'étoit qu'une seule et même comète que c'étoit divisé en deux: *quandoque bonus dormitat Homerus.*"

The Plates in the present number represent the sketch referred to in Mr. With's paper, and the two drawings referred to in Mr. Newall's letter.